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PATENT SPECIFICATION

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Index at acceptance :—Class 40(iv), J1(f2 : k : l).

COMPLETE SPECIFICATION

Improvements in Sound Reproducing Devices

We, MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, a British Company, of Marconi Offices, Electra House, Victoria Embankment, London, W.C.2, Assignees of JOHN PRESTON, a Citizen of the United States of America, of 131, West Broad Street, Hopewell, New Jersey, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

The present invention relates to sound reproduction devices, and more particularly to loud speakers.

Many factors govern the performance of a direct radiator loud speaker. The conditions which are favourable for maximum efficiency at the high frequencies are not the same as those which obtain for maximum efficiency at the low frequencies. In order not to overload the speaker, with the resultant production of harmonics, it is necessary to use a relatively heavy cone at the low frequencies. At low frequencies, the mass reactance of the air load is usually comparable to the mass reactance of a moderately heavy cone, so that the loss in efficiency incurred by the use of a heavy vibrating system is not serious. In the high frequency range the main obstacle to good efficiency is the large mechanical reactance of the vibrating system. A number of loud speakers comprising two separately driven cones have been proposed. In one such proposal, a high frequency cone is mounted in the same baffle as a low frequency cone. In another proposal, the same high frequency cone is mounted in front of the low frequency cone. All these proposals exhibit phase distortion and anomalies in the directional pattern in the cross-over range because the two sounds from the low and high frequency cones do not issue from a common origin.

The object of the present invention is to provide a direct radiator sound reproducing device having improved wave pattern characteristics over a wide range of frequencies and which is simple and inexpensive.

According to the invention there is provided a sound reproducing device comprising a magnet including an outer pole piece and a centre pole piece of opposite polarity having a recess therein, said pieces being spaced to form an annular air gap, a voice coil in said air gap, a second magnet detachably mounted in said recess and having a pole piece of opposite polarity to said centre pole piece forming an air gap with said centre pole piece, a second voice coil in said last mentioned air gap, a low frequency vibratile diaphragm connected to said first-mentioned voice coil and a high frequency vibratile diaphragm connected to said second mentioned voice coil.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawings, in which:

Figure 1 is a front view of a duplex speaker according to one embodiment of the present invention ;

Figure 2 is a section on line II–II of Figure 1 ;

Figure 3 is a sectional view of another embodiment of the invention ;

Figure 4 is a sectional view of a further embodiment of the invention ;

Figure 5 is a wiring diagram of a circuit which may be employed for energising the two voice coils of the sound reproducing devices shown in Figures 1 to 4 ; and

Figure 6 is a response graph of a sound-reproducing device according to the present invention taken over a frequency range of 30 to 15,000 cycles.

Referring to Figures 1 and 2 of the drawings, the loud speaker shown comprises two nested overlapping cones 10 and 11 made of vibratile material, such as heavy paper or the like now well known in the art of direct radiator loud speakers. The cone 10 is relatively large for the purpose of reproducing frequencies in the lower audible range of between 40 and 1,500 cycles, while the cone 11 is relatively small in order to reproduce frequencies in the higher audible range of

between 1,500 and 15,000 cycles. Both cones 10 and 11 are of truncate shape to provide annular base portions 12 and 13 respectively, the former being joined to an annular cylindrical voice coil 14 and the latter being joined to an annular cylindrical voice coil 15, the two coils 14 and 15 thereby respectively forming the driving sections for the two cones.

For producing the magnetic field, a suitable magnetic structure is provided comprising, in the present instance, a permanent magnet 16 having an annular pole 17 encircling the voice coil 14, and a centre pole 18 coaxial with the two cone base portions and having its forward end encircled by the voice coil 14. This pole 18 is formed with a central bore 19 and has an annular pole piece 20 mounted to encircle the voice coil 15 of the small cone 11. Within the bore 19 is a second permanent magnet 21 which is attached to a base 22 of soft iron fitted transversely within the bore 19 and locating the magnet 21 coaxially with respect to the base of the cone 11. A sleeve 23, also preferably of soft iron, encircles the magnet 21 and abuts the pole 20, thereby forming a complete assembly readily removable from the pole piece 18. The magnet 21 terminates in a cylindrical head, which in assembled condition is encircled by the voice coil 15. Thus, the complete magnet assembly comprises the magnet 16, pole 17, voice coil 14, centre pole 18, annular pole 20, voice coil 15, and magnet 21, all of said parts being concentrically arranged coaxial with respect to the cone bases. From this construction it will be seen that the lines of magnetic flux for poles 17 and 18 pass through voice coil 14, while the lines of magnetic flux for poles 20 and 21 pass through voice coil 15.

For mounting the cone 10 a spider 24 is attached at its end of smaller diameter to the annular pole piece 17 and terminates at its end of larger diameter in a ring 25, to which the outwardly turned flexible margin of the cone 10 is clamped by a ring 26 and screws 27. The marginal edge of the small end of the cone 10 is supported by a flexible member 28 stretched between the cone end and the end of the spider 24 attached to the pole piece 17.

For mounting the cone 11, a spider 29 is attached to the pole 20 and carries a ring 30 to which the outwardly turned flexible margin 31 of the cone 11 is clamped. The marginal edge of the small end of the cone 11 is supported by a flexible member 32 from a ring 33 anchored to the annular pole piece 20. A compliant member 34 may be interposed between the two cones and allows the cone 11 to vibrate independently of the cone 10.

Referring to Figure 3 of the drawings, those parts which correspond to like parts in Figure 2 have the same reference numerals since the description thereof remains unchanged. The centre pole 35, which is common to the magnets 16 and 21, is formed as a solid block supported coaxially of the magnet 16 and having its forward end provided with a recess 36 in which the magnet 21 is located. This magnet 21 is attached to a base 37 detachably connected to the bottom of the recess by screws 38 or like removable fastenings.

Referring to Figure 4, the modification concerns the mounting of the high frequency cone 11, while that of the low frequency cone remains unchanged from the forms of Figures 2 and 3, and therefore the parts thereof are respectively identified by the same reference numerals. In Figure 4 the centre pole 40 of the magnet is a solid block, for example of soft iron, supported coaxially with respect to the cone 10 and having an end recess 41, which receives a cup-shaped member 42, the bottom of which supports a permanent magnet 43 of a length to enter the voice coil 44, which in turn is encircled by the annular pole 45.

For mounting the high frequency cone 46, a flanged ring 47 is attached to the outer end of the centre pole 40 and the marginal edge of the large diameter end of the cone is secured to the annular outer end of ring 47, for example by means of a further ring (not shown) screwed to ring 47 with the marginal edge of the large diameter end of cone 46 clamped therebetween. The marginal edge of the small diameter end of the cone 46 is supported by a suitable compliant member 48 from the pole 45, in which position it is arranged to be actuated by the voice coil 44. It should be noted that the length of the ring 47 (axially considered) is such that the slope of cone 46 is substantially the same as that of the cone 10, and the mounting is so positioned relative to the mounting of the cone 10 that the surface of the cone 46 is substantially a continuation of the surface of the cone 10, and interrupted only to properly locate the voice coil 14. The leads 50 to the voice coils are brought into operative connection in any convenient way and terminate exteriorly of the speaker for cable attachment as will be understood.

In order that the high frequency speaker may be readily removed as a unit for repair or replacement, an elongated screw 51 passes axially through the pole 40 to thread into the base of the member 42 and thus retain the magnet 43 and the associated parts in place. When it is desired to remove the high frequency cone, the voice coil leads 50 are disconnected from the exterior connections and the screw 51 removed so that the member 42 is free to be pushed out of the recess 41 by any suitable push rod entering the pole 40 through the hole vacated by the screw 51, and of a length to shift the cone unit out-

wardly to a position where it can be grasped and removed.

The pairs of voice coils may be connected as shown in Figure 5 with a capacitance 52 of suitable value connected in series with the high frequency voice coil.

In the construction described with reference to Figure 4, it will be seen that the large cone 10 is a virtual continuation of the small cone 46, because the cone angles are substantially the same and the cone 46 lies sufficiently within the cone 10 to bring the two cone surfaces into substantial alignment. This alignment is brought about by so positioning the cone 46 within the cone 10 as to locate the large marginal edge of the cone 46 substantially in the plane of the marginal edge of the small end of the cone 10.

In all the constructions described the arrangement is such that the centre pole (18, 35 or 40) which extends within the voice coil connected to the large cone, also constitutes an outer magnetic path for co-operation with the magnet (21 or 43) associated with the high frequency cone.

As shown in Figure 5, the two cones of the loud speakers according to the invention may be energised by the use of a simple overlap network without encountering a ragged response in the overlap region. By reference to the frequency graph of Figure 6, it will be seen that a smooth response $\pm$ 2 db. from 40 to 15,000 cycles is obtained.

While the magnets shown in the above-described embodiments of the invention are of permanent magnet construction, they could be energised electro-magnetically, as will be understood.

Furthermore, it should be particularly noted that the high frequency cone is entirely independent of the low frequency cone and hence the vibrations of neither cone can be transmitted to the other to produce the heretofore objectionable interference and distortion of the combined vibrations.

It is to be understood that in the foregoing description the term " cone " is used in a broad sense and does not necessarily mean a cone in the strict geometrical sense.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is :—

1. A sound reproducing device comprising a magnet including an outer pole piece and a centre pole piece of opposite polarity having a recess therein, said pieces being spaced to form an annular air gap, a voice coil in said air gap, a second magnet detachably mounted in said recess and having a pole piece of opposite polarity to said centre pole piece forming an air gap with said centre pole piece, a second voice coil in said last mentioned air gap, a low frequency vibratile diaphragm connected to said first mentioned voice coil and a high frequency vibratile diaphragm connected to said second mentioned voice coil.

2. A sound reproducing device according to Claim 1 wherein said diaphragms are mounted so that the surface of one diaphragm is in substantial alignment with the surface of the other diaphragm.

3. A sound reproducing device according to Claim 1 or 2, wherein the magnet mounted within said recess and the associated diaphragm and voice coil form an assembly removable as a unit from the sound reproducing device.

4. A sound reproducing device substantially as hereinbefore described with reference to Figures 1 and 2 or Figure 3 or Figure 4 of the accompanying drawings.

Dated this 1st day of January, 1946.

F. W. CACKETT,
Chartered Patent Agent.

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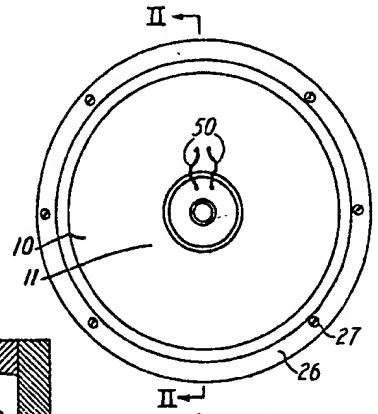


Fig. 1.

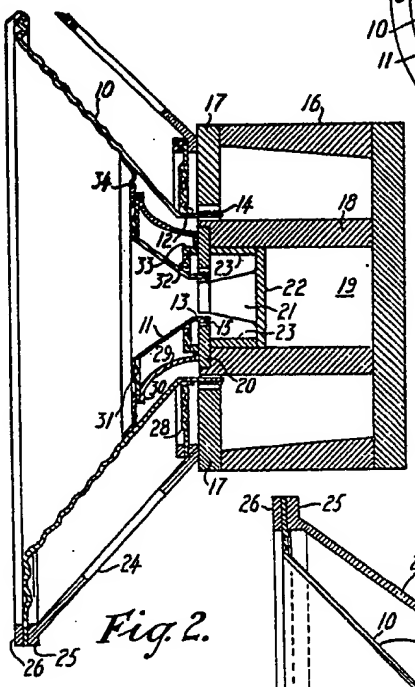


Fig. 2.

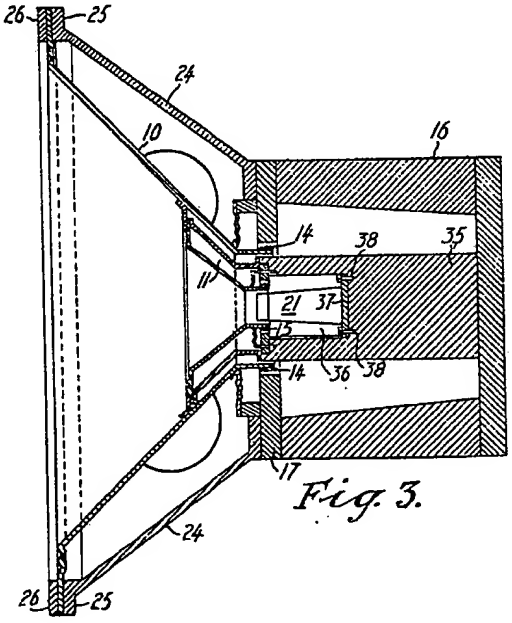
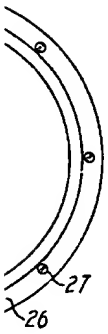


Fig. 3.



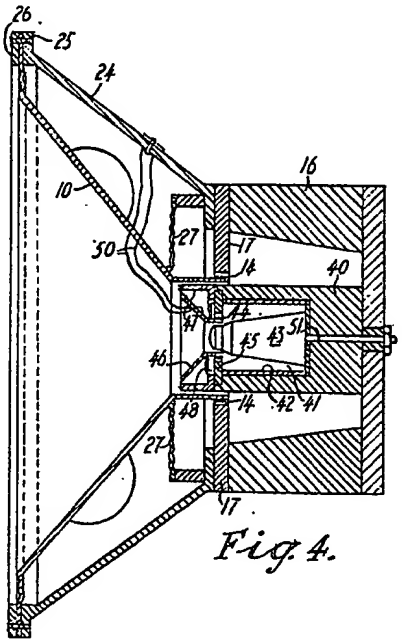


Fig. 4.

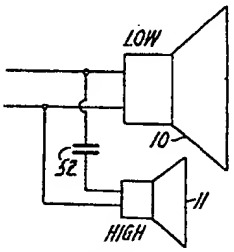
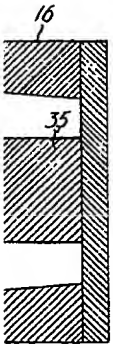


Fig. 5.



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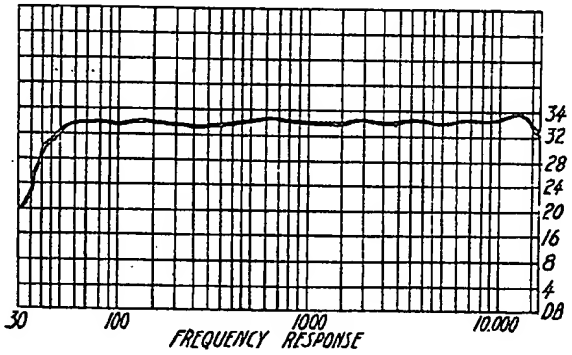

Fig. 6.

SHEET 1

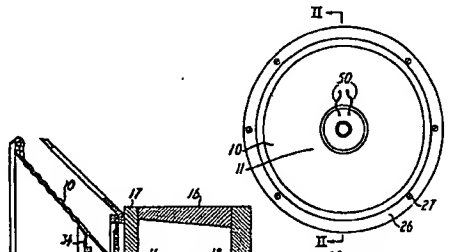

Fig. 1.

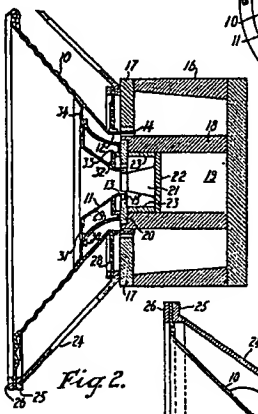

Fig. 2.

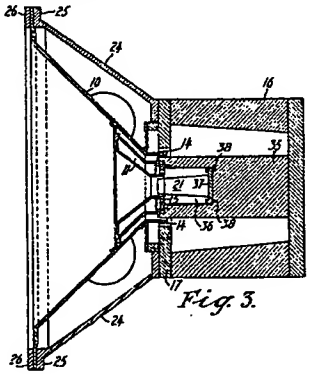

Fig. 3.

SHEET 2

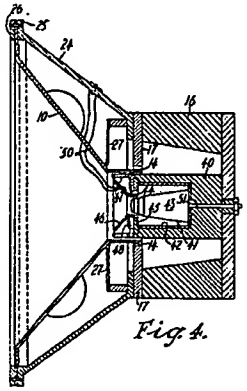

Fig. 4.

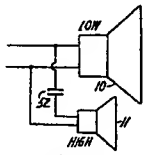

Fig. 5.

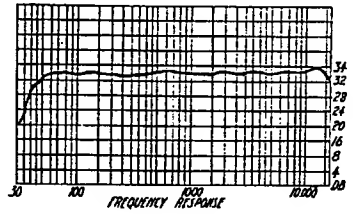

Fig. 6.

H.M.S.O. (M.F.P.)